July 30, 2007

I, Steve M. Hays PE, CIH, have submitted this report as a rebuttal to various opinions presented in initial and rebuttal reports by the following Grace experts: Elizabeth Anderson, Gordon Bragg, Richard Lee, Peter Lees, and Suresh Moolgavkar. My previous report is dated June 8, 2007. This report is based on a review of Grace expert witness reports and rebuttal reports provided by Caplin & Drysdale, the documents, literature and exposure assessment studies cited in this report, on my experience and qualifications as a certified industrial hygienist, and on my qualifications and experience as a licensed professional engineer. My curriculum vitae is in Appendix A. Selected industrial hygiene, scientific, and regulatory publications upon which I relied are cited in Appendix B. I also relied on my general knowledge in the topic areas, including my library of relevant publications.

The purpose of this report is to provide opinions about exposure and potential exposure to airborne asbestos from asbestos-containing products, with special emphasis on spray-applied fireproofing products, spray-applied acoustical plasters, and expanded vermiculite thermal insulation.

Text from my previous report relevant to each topic is shown in *italic* for the convenience of the reader. Citations in the italic text have been renumbered to coincide with the reference list attached to this rebuttal report, and in some instances have been supplemented.

1. The permissible exposure limits (PELs) set by the Occupational Safety and Health Administration (OSHA) and the threshold limit values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are not excessively stringent and overly protective. These limits have scientific validity and are compatible with prudent industrial hygiene practice for protecting people from a known and confirmed human carcinogen.

Both OSHA and ACGIH explain the scientific basis in great detail, along with the rationale, for setting exposure limits. Included in those rationales is the recognition of individual susceptibility, and OSHA admits that its current PEL is not fully protective. Some individuals will not develop asbestos-related disease even after exposures much higher than the PEL, and some will develop disease with small exposures of short duration. Good industrial hygiene practice dictates that people be protected from exposure to toxins, especially carcinogens, and the exposures should be kept as low as reasonably achievable. These current exposure limits are certainly achievable, and they are consistent with prudent practice. The literature cited by OSHA and ACGIH establishes that the limits are necessary and credible. The number of asbestos related diseases which continue to occur is proof that past actual exposures were too high, regardless of regulated limits at any given time, and that compliance with prior standards afforded inadequate protection to workers.

OSHA is required by its enabling legislation to consider economic and technical feasibility when setting standards. ACGIH is a private, not-for-profit organization, not under the constraint of considering economic and technical feasibility, and considers its recommended limits to be based solely on health effects. The two organizations arrived at the same 8-hour time weighted average (TWA) exposure limit for asbestos in all its mineral forms; therefore, the current limits are clearly both health based and feasible to achieve, within the context that both organizations note some remaining risk at the current limits.

In 1971, the U.S. Occupational, Safety and Health Agency (OSHA) published its first asbestos regulation. In 1971 the U.S. Environmental Protection Agency (EPA) listed asbestos as a hazardous air pollutant.

OSHA's first asbestos exposure standard in 1971 was 5 fibers per cubic centimeter of air (f/cc). The permissible exposure limits (PEL's) have been reduced several times since to the current limits of 0.1 f/cc for an 8-hr time-weighted average (TWA) and 1.0 f/cc over a 30 minute sampling time (Excursion Limit). Even these current PELs are not considered

by OSHA to be fully protective.[1] *OSHA regulates all forms of asbestos minerals (chrysotile, amosite, etc.) in the same manner because all types are known to cause disease; the EPA also regulates all asbestos types in the same way.*

The American Conference of Governmental Industrial Hygienists (ACGIH) in 1946 published its recommended exposure standard for asbestos. The standard was called a maximum allowable concentration (MAC) and was set at 5 millions of particles per cubic foot (mppcf) as an 8-hr TWA.[2] *This measurement was by use of an impinger, and the analytical result was reported as the number of counted dust particles, per volume of air, collected in the impinger. The adequacy of the ACGIH MAC, which remained at 5 mppcf through 1973, was called into question in the literature in 1964.*[3] *In 1968 two published articles concluded that the MAC was too high.*[4, 5] *The ACGIH standard, which is now called the threshold limit value (TLV), has been reduced many times since and is currently at 0.1 f/cc as an 8-hr TWA. This measurement is specific to fibers, rather than all dust; however, the technique does not distinguish asbestos from non-asbestos fibers. The ACGIH definition of the TLV is "the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that* ***nearly all*** *workers may be repeatedly exposed, day after day, without adverse effect."*[6] *{emphasis added}*

The EPA recognized the concept of limiting asbestos exposure while installing certain asbestos-containing products in 1973. "This set of regulations includes a 1973 ban on the use of spray-applied asbestos-containing materials in buildings for insulating or fireproofing purposes, except for equipment, as well as the specification for "no visible emissions" from permitted spraying, as published in the FEDERAL REGISTER (38 FR 8826)"[7] *"The health hazards of spray application of asbestos to spray operators, other construction workers, and the general public in the vicinity of such operations were recognized and documented"*[8] *Paik et al. agree that "In 1973, the U.S. Environmental Protection Agency (EPA) banned the spray application of fireproofing material containing more than 1% asbestos by weight because occupational hazards associated with inhalation of asbestos fibers had been well established."*[9]

The current OSHA PELs of 0.1 f/cc for an 8-hr TWA and 1.0 f/cc over a 30 minute sampling time (Excursion Limit) should be considered when understanding the magnitude of exposure for people manufacturing, installing, repairing, removing, or replacing asbestos-containing products. The EPA asbestos abatement clearance standard for schools should also be considered.

2. Exposure ranges and averages can be reasonably estimated based on historical exposure data, work practice simulation studies, and other relevant studies. These sources are not limited in reliability and usefulness to only those products, work practices, and site conditions studied. They can also be used to estimate average exposures and/or ranges of exposures for work done with similar but not precisely the same product (e.g., spray-applied fireproofing manufactured by another company), similar but not precisely the same work practices, and similar but not precisely the same site conditions.

Historical exposure data are limited in quantity and scope. It is unreasonable to assert that such historical data, simulation data, etc. can only be reliable for estimating exposures that match in every detail the historical events, the simulations, etc. It is standard industrial hygiene practice to consider, with appropriate care, all data which may have bearing on a worker's exposure. If industrial hygiene were limited to estimating exposures only where historical data existed as an exact match for the situation under assessment, there would be no meaningful and practical way to predict average exposures and/or ranges of exposures for the boundless variety of work places, work practices, and products in commerce today and historically. Without exposure estimates (both retrospective and prospective), health effects could not be related to workplace conditions, adequate exposure limits could not be established, and epidemiology studies would have insufficient foundation related to environmental conditions. This situation would preclude adequate worker protection and make workers "canaries" like those birds used in coal mines in times past. Historical exposures related to the products at issue can be reasonably estimated using data, whether historical or contemporary, that are derived from products, work practices, and work site conditions as long as sufficient and relevant similarity is logically established.

During the accelerated application of asbestos in commerce in 1930s and 1940s, occupational assessments were relatively few, and these assessments were conducted in conditions of relatively high exposure because asbestos was not regulated then as now, and adequate dust suppression techniques were not commonly in use. Asbestos manufacturers touted the benefits of the mineral and with time introduced many products into commerce. Since the health effects are not usually acute, and a long latency exists for disease manifestation, medical doctors and industrial hygienists did not rapidly quantify cause and effect. After the relationship between asbestos and disease was obvious, ACGIH began to lower its recommended TLVs. However, this happened after many years of missed opportunities to study exhaustively exposure in the workplace. Such data would have provided a better exposure characterization foundation for epidemiology studies; however, those data would have done little to inform the occupational health community about the risk attendant to low level exposures.

Historic exposures were mostly measured using an impinger, which gave results in million particles per cubic foot of air (mppcf), or using phase contrast microscopy (PCM) to examine sampling filters, which is an optical microscopy technique that gave results in fibers per cubic centimeter of air (f/cm^3). The PCM method measures only fibers equal to or longer than 5 micrometers, with an aspect ratio (length to width) of equal to or greater than 3 to 1. Short fibers are not counted, and thin fibers are not even seen by the analyst because the optical scope cannot resolve fiber widths less than 0.25 micrometers. Given these limitations, PCM data alone offer no direct instruction about the presence of short and thin fibers; therefore, most historic data are not useful in quantifying these unmeasured fibers. There is no validity to the assertion that these fibers are not harmful. The most that can be said is that they were not historically measured. The mppcf measurement gives no information about fiber size, large or small, since it only provides a total numerical count of dust particles present. With these historic data, and with contemporary PCM data, the total number of fibers present and the fiber size distribution are not known. Using historic data on average exposures or ranges of exposures in a given operation or job to estimate exposures for an individual or a cohort must be done with these limitations in mind.

Exposures in any individual case are influenced by many variables. These include, but are not limited to, the work being done, the particular method by which the work is done, ventilation (mechanical or natural), air flow patterns and characteristics, types of asbestos-containing products, proximity to the work, duration of the work, and duration of fiber settling times. Given these variables, it is logical that an individual's exposure profile may have a broad range for any given time period or job, and certainly for a career. Indeed, the fact that the average exposure for a particular trade or job may be low does not mean that the exposure was low for every worker in that trade or for every worker doing a particular task. Historic and contemporary data confirm this variability. For industrial hygiene purposes, ranges are often more useful in understanding exposure than are averages. Air samples are integrated over the time periods of the individual samples, so there can be a range of exposure within each individual air sample that is unknown. For example, if an air sample is taken for 4 hours (240 minutes) and the reported result is 1.0 f/cm^3, that number could represent 30 minutes at 5.0 f/cm^3 (500% of the reported result) and 210 minutes at 0.4 f/cm^3 (40% of the reported result). The possibilities for the range of exposures are many for every air sample. Instantaneous, real time measurements specific to asbestos were not, and are not, done. Hence, exposure is affected by the workplace variables mentioned above, and the assessment of exposure is affected by the measurement techniques themselves. The full range of exposures even for a given workplace may not be known if both the highest and lowest concentrations were not measured, and even if the extremes were measured the data are subject to the limitations of the integrated sampling methodology. The variables in the workplace and limitations in the sampling methodology must be understood to prevent bias in interpretation of data and studies.

Most workers were exposed to a variety of asbestos products and worksite conditions over their working lifetimes. For any given worker or group of workers it is impossible to know the exact lifetime exposure profile. In particular, averages or ranges observed in a study cannot be used to definitively establish the exposure to which any particular individual was subjected. Even for periods where sampling data exist, each air sample represents a range of exposure within the sample that is unknown. Some exposures could be more or less than the averages reported, and it is very possible for any worker to be exposed to periods of extreme airborne asbestos concentrations which are not segregated by the sampling methodology.

Even if a large database existed of exposure measurements specific to only one asbestos-containing product, it would be rare to find a person in an asbestos-related industry who was exposed to only that product for his/her entire work history. OSHA recognizes this. "Third, the record shows that employees are likely to be exposed to **mixed fiber types** at most construction and shipyard industry worksites most of the time."[1] {emphasis added} Also, from Lemen et al., "In most industrial processes different types of fiber are mixed, so that pure exposures to a single asbestos type are rare."[10] It would be impractical for an industrial hygienist to base exposure estimates solely on data limited to only one product or manufacturer.

As an industrial hygienist, I believe that any exposure above ambient background is to be avoided and any such exposure may contribute to disease in some individuals. The human respiratory system is not selective as to the source (product) of airborne asbestos during inhalation; therefore, if there actually is a lifetime dose-response relationship for some diseases, any asbestos body burden added by workplace exposure above ambient contributes to risk of disease, regardless of the product types, manufacturers, worksites, or exposure averages. If no safe threshold exists for some asbestos-related conditions, such as mesothelioma, then the conclusion is the same.

"A major goal for the industrial health and hygiene professionals in the 1960s was to improve worksite safety and reduce high level asbestos exposures that occurred during

the manufacture and use of asbestos products containing raw and friable asbestos that were used in large volumes in construction and in shipyards."[11] *It was clearly recognized that "when new asbestos insulation is applied or when old insulation is removed; considerable quantities of fiber may become airborne and, unless controlled, may lead to excessive inhalation exposures to the workers."*[12] *Until the restrictive presence of regulatory agencies like the EPA, and OSHA, installing asbestos and disturbing material that contained asbestos were not controlled in acceptable fashion. Worksites were not routinely measured for asbestos concentrations. In 1972, "The lack of environmental data for previous years and the changes in technology used to collect samples, now and in the past, have resulted in the availability of comparable environmental data for only the last few years. Thus, the scant data and the long latent period for the development of bronchogenic cancer and mesothelioma do not permit the establishment of the dose response relationship at this time. However, as has been indicated, the development of the diseases has been proven in workers exposed to asbestos and the environmental data does exist for the last several years."*[13] *It was not until the asbestos hazard was recognized in a national and regulatory theater that an abundance of studies were produced. Pre-OSHA, the majority of sites where asbestos was used and installed were not evaluated. Therefore, the majority of existing asbestos studies deal with the disturbance of in-place asbestos-containing products rather than installation or production.*

While air sampling is reliable to measure exposure, great care must be exercised in data interpretation. Sample results are sometimes variable due to the many factors that influence fiber dispersal in air. A single sample result may be representative of the average exposure under the sampled conditions; however, it may also be more representative of an extreme, either high or low. A worker's exposure over a given time period can be estimated from measured concentrations, but unless the measurements are continuous over the time period, judgment must be used to assess what the results mean.[14]

Industrial hygienists use many techniques to assess exposure when little or no data exist for a given situation or worker. Conclusions may be drawn from data in the literature if conditions have sufficient similarity to the case of interest. Simulations are reliable for estimating exposure.[14] These data sources can be used to establish a likely range of exposures and probable average. For a given worker, however, the actual exposures at the extremes may be more or less than studies and literature indicates. General conclusions about exposures of a given worker population may not be accurate for an individual worker.

Industrial hygienists also may use retrospective exposure modeling for a given situation where actual data do not exist. This mathematical approach requires the use of many assumptions about what actually happened in the workplace and must also rely on studies and/or data collected under similar circumstances.

3. Exposure to airborne asbestos occurs to workers who install these products and to those who repair, remove, or otherwise disturb these products after installation. Exposure also occurs to workers who clean-up asbestos debris and dust. While all of these activities are in progress exposure to airborne fibers occurs to other people (bystanders) in the immediate vicinity and in some circumstances to people distant from the activities. The duration of exposure depends on the circumstances and can last for significant time periods after asbestos-related activities have ceased. People exposed to asbestos-containing dust can carry contamination on their clothing out of the workplace and thereby expose people in other locations while continuing to expose themselves.[15]

It is simply incorrect to assert, as Grace experts do, that only those workers who were directly involved in mixing or installing or otherwise manipulating an asbestos-containing product could have been exposed to substantial asbestos from that product. As described in my June 8, 2007, expert report, the installation, removal, operations and maintenance (O&M) activities, and housekeeping related to asbestos-containing **fireproofing,** asbestos-containing **acoustical plaster,** and asbestos-containing **Zonolite attic insulation,** and similar products resulted in substantial asbestos exposure to so-called "bystanders" as well as those working directly with the products.[4, 5, 7, 9, 13, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43] "Bystander" is used in this

report to mean any people who are in the vicinity of asbestos related work but not actually themselves manipulating the asbestos-containing products. These can be persons of other construction trades, laborers, vendors, delivery people, equipment operators, industrial process operators, managers, casual observers, etc. Exposure to bystanders can be as high as to people actually doing the work with the ACMs (asbestos-containing materials).[21] Other studies demonstrate the same thing.[19, 22, 23, 31, 32, 33]

Workers or bystanders describe clouds of dust produced from the asbestos-related activity being performed. Depending on the percentage of asbestos in the product this dust cloud will contain varying levels of asbestos. If a dust cloud is visible to the unaided eye, then the airborne concentration is well above 5 mppcf.[44] *Conversely, airborne asbestos concentrations can be very high even if dust is not visible in the air. Like most other breathable hazards, concentrations of airborne asbestos can be decreased or increased due to particular prevailing conditions such as presence of ventilation, airflow, atmospheric conditions, amount of asbestos in the product used or disturbed, presence of other co-workers pursuing the same asbestos-related activity, workers' proximity to asbestos-related activity, and the sometimes numerous and different approaches to the same asbestos-related activity.*

Worker Installation and Disturbance

Spray-applied asbestos-containing fireproofing, spray-applied asbestos-containing acoustical plaster, and Zonolite Attic Insulation are significant sources for airborne asbestos fibers. Exposure can occur during 1) Installation, 2) Removal, 3) Operations and Maintenance (O&M) activities and Housekeeping.

Bystander

"The population at risk includes not only those engaged in the manufacture and use of asbestos products, but also bystanders and others limited to neighborhood or familial exposures."[34] *Grandjean and Bach state that "Indirect exposure may occur at work when*

adjacent workers are exposed to hazards originating from fellow workers' activities. Indirect exposures of household members may occur when hazardous substances are carried home (e.g., in the clothing)."[45] *In other words, people who were not directly involved in the manufacture, use, installation, repair, and removal of asbestos-containing products could be at risk. In the repair, renovation, construction, and shipbuilding industries it is very common for multiple trades to be working side by side, or in an overlapping manner. This is referred to loosely as sequencing. For example, with regard to installation of asbestos-containing products, it would not be uncommon to see pipe fitters working near pipe insulators; it also would not be uncommon for white collar workers to episodically pass through this aforementioned area for unrelated purposes. "Concern used to be focused on the occupational environment, but it is now recognized that asbestos fibers are widely distributed in the general environment. Persons can be exposed to asbestos in different non-occupational circumstances: living with asbestos workers, with regular exposure to soiled work clothes brought home; environmental exposure in the neighborhood of industrial sources (asbestos mines and mills, asbestos processing plants); passive exposure in buildings containing asbestos…"*[46] *In the course of a blue collar worker's career it would not be uncommon for him/her to be exposed to varying degrees of airborne asbestos fibers, especially during the height of asbestos use, during the 1950's, 1960's, and early 1970's.*[47] *In a 1972 study, it was noted that, "The application of sprayed asbestos coatings has been classified as an operation producing heavy concentrations, not only in the operator's breathing zone but also in adjacent areas."*[26] *"While most studies of asbestos and the development of human disease have focused on individuals occupationally exposed, there is an increasing body of evidence that non-occupational exposure, usually called environmental or bystander exposure, can lead to the development of asbestos-related disease."*[48] *The scientific literature states as such.*[13, 15, 19, 20, 21, 22, 23, 24, 27, 28, 30, 31, 32, 33, 34, 38, 45, 46, 49, 50, 51]

Dust

There are no regulated limits for asbestos in settled dust. The potential for settled dust to create unacceptable exposures to airborne asbestos, however, is recognized by both the

U.S. EPA and the U.S. OSHA in their respective regulations, guidance documents, and interpretations. The existence of in-place ACMs in buildings does not cause exposure per se to airborne asbestos. However, the mere existence does create significant exposure potential, and uncontrolled disturbance of installed product and/or settled dust will result in very high airborne concentrations. The disturbance of asbestos-containing products and dusts, and the subsequent elevated exposures, is a theme in many different studies, guidelines and regulations.[1, 2, 17, 18, 23, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 44, 48, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65]

4. All types of asbestos are carcinogenic. There is no basis for regulating exposure to various mineral types differently. Standard industrial hygiene practice is to protect all workers from exposure to carcinogens to a level as low as reasonably achievable. Most of the asbestos used in the US was and is chrysotile, and asbestos related disease continues to manifest in this country; therefore, it makes little sense to claim that chrysotile is safe.

Upon examining 151 lung tissue samples from mesothelioma cases, “the most majority of asbestos types seen in the mesothelial tissues were chrysotile alone, followed by chrysotile and amphibole and amphibole alone.”[66] Sturm et al. concluded that “A considerable percentage of mesotheliomas are solely due to exposure to chrysotile asbestos.”[67] “The case that chrysotile is a potent causative factor in producing mesothelioma is a strong one. It is shown to be so in a comparison of more than 40 studies of different fiber exposure circumstances.” According to Smith and Wright “Reported data do not support widely supported views regarding the relative inertness of chrysotile in mesothelioma causation…. Since asbestos is the major cause of mesothelioma, and chrysotile constitutes 95% of all asbestos use world wide, it can be concluded that chrysotile asbestos is the main cause of pleural mesothelioma in humans.”[68] Multiple studies concur with this idea.[69, 70, 71, 72, 73, 74, 10, 75, 76, 77, 78]

ATSDR states that “All forms of asbestos are hazardous, and all can cause cancer, but amphibole forms of asbestos are considered to be ***somewhat*** *more hazardous to health than chrysotile.”*[47] *{emphasis added} Grace experts contend that fiber type and length are extremely important with regard to potential exposure risk. In discussions about*

fiber type, OSHA says that "After a comprehensive review of the evidence submitted concerning the validity of the 1984 risk assessment, OSHA has determined that it will continue to rely on the earlier analysis. The Agency believes that the studies used to derive risk estimates remain valid and reliable, and that OSHA's decision to not separate fiber types for purposes of risk analysis is neither scientifically nor regulatorily incorrect. There are at least three reasons for OSHA's decision not to separate fiber types.

1. *First, OSHA believes that the evidence in the record supports similar potency for chrysotile and amphiboles with regard to lung cancer and asbestosis. The evidence submitted in support of the claim that chrysotile asbestos is less toxic than other asbestos fiber types is related primarily to mesothelioma. This evidence is* ***unpersuasive****, and it provides an insufficient basis upon which to regulate that fiber type less stringently.*

2. *Second, as stated in the 1986 asbestos standard, even if OSHA were to accept the premise (which it does not), that chrysotile may present a lower cancer risk than other asbestos fiber types, occupational exposure to chrysotile asbestos still presents a significant risk of disease at the revised PEL (See 51 FR 22649, 22652). In particular, asbestosis, the disabling and often fatal fibrosis of the deep portions of the lung, is caused by exposure to all types of asbestos. The evidence on this is strong and no new information has been presented to contradict this. As stated above, OSHA estimated asbestosis risks at 0.2 f/cc exposures as an unacceptably high 5 cases per 1000 workers. Thus, asbestosis risks alone justify the regulation for chrysotile…*

3. *"Third, the record shows that employees are likely to be exposed to* ***mixed fiber types*** *at most construction and shipyard industry worksites most of the time. Assigning a higher PEL to chrysotile would present the Agency and employers with analytical difficulties in separately monitoring exposures to different fiber types. Thus, regulating different fiber types at differing levels, would require more monitoring all the time and would produce limited benefits (51 FR 22682)."*[1] {emphasis added}

In a letter from the WHO, it is clearly stated that "all types of asbestos cause asbestosis, mesothelioma, and lung cancer."[79] *According to Dr. Richard Lemen, "We are at a point in the history of asbestos usage where chrysotile is the predominant type asbestos produced and consumed in the world today; it constituted about 98.5% of US consumption in 1992…A review of 92 consecutive cases of mesothelioma found that even while only 28.3% of the asbestos fiber type in the lung was chrysotile, it was the major fiber type identified in the mesothelial tissue itself. These findings further suggest that lung burden analysis for determining fiber type in mesothelioma etiology may not be appropriate and that determining predominate fiber type in the mesothelial tissue is the more rational determinant."*[80]

5. Small fibers are not exonerated from toxicity. Transmission electron microscopy (TEM) is far superior to PCM for determining fiber size. When small fibers are measured in air samples, they generally outnumber the larger fibers counted with the PCM method.

When air sampling filters are examined by both PCM and TEM, the TEM result is usually higher than the PCM result for the same filter. This is usually because the TEM method detects and counts fibers shorter and thinner than those counted by PCM, in addition to counting also the larger fibers that are counted by PCM. TEM data show that in most cases exposures are to a wide distribution of fiber sizes and shapes (called "structures" rather than fibers in some instances). It is not logical science to conclude that smaller fibers are not toxic simply because historic data did not record their presence in air samples.

In my previous report, I presented literature to show that small fibers are toxic (see text below in *italic*). Additional literature on this subject includes Egilmen (2004), Lemen (2004), and Fubini (2001).[81, 82, 83]

With regard to fiber size, Jenkins states that "Some may argue that the smaller WTC fibers are less hazardous than the larger fibers. To my knowledge, the federal EPA has not addressed this scientific theory and issued any guidance to discount any cancerous effects of fine asbestos fibers. If such a recommendation were to be issued, it would first

undergo extensive internal and external peer review, and be subjected to due process through a notice and comment period. Until such time as this occurs, as a matter of prudent public health policy, it would be inappropriate to downgrade a risk assessment based on this theory. I have also been informed that EPA has no intention of downgrading the risk based on this theory."[56] *According to Dodson and his research, the regulated fiber size (≥ 5µm) "selection criteria were based on "practicality and theoretical considerations" rather than having a target of a "more toxic" population of fibers."*[48] *According to Sawyer and his research, the "counting of only those fibers 5µm or longer is inappropriate. Airborne fiber sizes range from hundreds of microns to fibrils of submicron dimensions, and the size distribution of asbestos particles in human tissues studied by electron microscopy is in most part less than 5 µm."*[34] *In a 2001 study, researchers conducted fiber burden analysis in a series of individuals with mesothelioma who were 50 yr or less of age at time of diagnosis. They concluded that "shorter fibres were more abundant than longer fibres, and high concentrations of all fibre lengths tended to occur together."*[84] *Dodson agrees that "…inhaled asbestos fibers cause asbestos-related disease and most frequently consist of a mixture of asbestos types and sizes."*[48] *According to Suzuki et al. the majority of the fibers in the lung and the mesothelial tumor tissue were less than 5µm in length.*[85] *"The fact that short fibers (< 5µm) have been shown to produce toxic effects in macrophages in vitro and to be fibrogenic tumorigenic in animals in vitro, and that they reach the site of mesothelioma development support the inappropriateness of discounting their role in asbestos-related disease as has been done…"*[48]

6. Grace experts cite brake pad studies to conclude that low level exposures over long duration are not harmful. Contrary evidence exists; therefore, this conclusion is overly broad and cannot withstand the same standard of scrutiny to which Grace experts attempt to hold claimants.

Grace experts contend that low levels of asbestos exposure will not cause mesothelioma. They cite friction product related workers as an example of an industry with low dose exposures, and conclude that no increase in mesothelioma occurs for this population.

Exposure to friction products, i.e. automotive brakes, occurs in installation, removal and repair. In a review by Lemen (2004) it was reported that "chrysotile asbestos was found in all dust samples taken from car brake drums, with 2-15% in each sample in both fiber and fibril forms, with average concentrations from blowing the dust of 16 fibers/ml of air…"[81] with measurable concentrations found 75 feet away. In Lemen's review it is noted that "fiber concentrations of 3.8 fibers/ml among New York brake repair workers"[81] were found. Furthermore, "Grinding of the linings produced the most asbestos fiber release, some as high as 125 fibers/cm^3…"[81] Lemen concludes, "A review of the published peer reviewed literature reveals at least 165 cases of mesothelioma in end-product users of friction products…and that the results of the exposure studies, experimental studies, case reports, and findings from the equivocal epidemiological studies by no means exonerate the brake mechanic from being susceptible to a causal relationship between asbestos exposure and mesothelioma."[81] Similar literature express this theme. In a Millette study (1996), during the sanding of an asbestos-containing friction product, asbestos fiber levels were 2.2 fibers/cc (PCM); during the making of grooves in the disc pad for two minutes with a power grinder, asbestos fiber levels were 8.0 fibers/cc (PCM). Millette further concludes that "Sanding an asbestos-containing brake shoe friction product with a coarse sandpaper released high levels of asbestos fibers in the breathing zone of the sander…Using a power muffler grinder to cut the grooves in an asbestos-containing brake disc pad causes high levels of asbestos to be released."[86] According to the EPA, "Millions of asbestos fibers can be released during brake pad and clutch servicing…Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed in by everyone inside a garage, including customers. While lowering exposure lowers risk, there is no known level of exposure to asbestos below which health effects do not occur...[mesothelioma] can be caused by very low exposures to asbestos. This cancer has occurred among brake mechanics, their wives, and their children."[87] "OSHA had stated that the 1983 Berry and Newhouse study of friction materials manufacturing workers which found nonsignificant increases in lung cancer mortality, was inconsistent with other studies showing that low level asbestos exposure resulted in excess lung cancer mortality, because of the relatively short follow

up period used (51 FR 22618)"[1] Other literature with similar concerns and conclusions is available.[48, 88, 89, 90, 91, 92, 93]

As noted above, OSHA does not consider the current PEL's to be fully protective. "OSHA's risk assessment also showed that reducing exposure to 0.1 f/ cc would further reduce, but not eliminate, significant risk."[1] *With regard to carcinogenic risk, the WHO concludes there is a no threshold exposure level below which exposure to asbestos dust would be free of hazard to health.*[52, 79] *In a 1991 joint EPA, NIOSH document, "NIOSH contends that there is no safe airborne fiber concentration for asbestos. NIOSH therefore believes that any detectable concentration of asbestos in the workplace warrants further evaluation and, if necessary, the implementation of measures to reduce exposures."*[17] *Cate Jenkins, of the EPA, states in a letter, that the "AHERA regulations explicitly state: "there are no safe exposures to asbestos"."*[53] *"Avoiding unnecessary exposure to asbestos is prudent."*[18] *It is my opinion that there is no basis for accepting any workplace exposure to asbestos as "safe."*

Various cancers, including mesothelioma, are known to be caused by asbestos at very low lifetime doses.[46, 49, 94, 95] *With regard to asbestos workers and low level exposure, "exposure levels below those allowed for asbestos workers, the risk of asbestosis is negligible. Some scarring of lung tissue may appear on X-rays after many years of low exposure, but no impairment of respiratory function is likely to occur.* ***However****, the incidence of lung cancer and mesothelioma exceeds baseline rates even at very low exposure levels."*[7] *{emphasis added}*

7. Actual exposure profiles for individuals and for worker cohorts are highly variable and never known precisely over long time periods. Even personal air samples are integrated over the sampling time and represent only an average for the time period of the sample. Peaks can occur within the sample time and are not distinguished by the sample result. Fibers per milliliter year (f/ml-yr) dilute the significance of any estimated exposure profile by averaging data points, which are themselves averages. Times of very high exposures can occur to an individual but be masked by the f/ml-yr method of exposure analysis. Even if the Grace expert's opinion of 15 f/ml-yr threshold is accepted for the sake of argument, simple math shows that a worker can

remain below this threshold for a career and still suffer periods of extreme exposure.

Moolgavkar states that “There are no reliable epidemiological data demonstrating the risk of disease following average cumulative exposures less than about **15f/ml-yr**. Most of the quantitative information on the risk of disease following exposure to asbestos is derived from epidemiological studies of cohorts of occupationally exposed workers.”[96] {emphasis added} A document referenced and relied upon by Moolgavkar[96] and Anderson[97] states that “Taking this evidence together we do not believe there is a good case for assuming any threshold for mesothelioma risk.”[98]

Anderson states that “The cumulative exposure is the product of the concentration on days when exposure occurred, the exposure frequency and the exposure duration; for example, an individual exposed at the level of 1 f/ml for one work day per week for a 45 year working life will accumulate a cumulative exposure of 9 f/ml.yrs (1 f/ml x 1/5 x 45 yrs). This example shows how sensitive the cumulative exposure estimate is to the assumptions of exposure duration and frequency.”[99] Anderson’s exposure scenario is below that of Moolgavkar’s risk threshold for the development of asbestos-related disease. That means that a person (worker, bystander) working one day (8 hours) a week (approximately 52 days of 260 work days per year or 1/5) at an exposure level equal to that of OSHA’s current Excursion Limit of 1.0 f/cc over a 30 minute sampling time, and ten times greater than that of OSHA’s PEL of 0.1 as a time weighted average, will accumulate 9 f/ml-yr, for a 45 year work period. This example bears exploration, and I will assume only for the sake of argument that Moolgavkar’s cumulative exposures threshold of 15f/ml-yr is credible.

Example 1

What if a person were exposed at 1.0 f/ml for more than one day a week for this 45-year period?

1 f/ml x 2/5 x 45 years = 18 f/ml-yrs

1 f/ml x 3/5 x 45 years = 27 f/ml-yrs

1 f/ml x 4/5 x 45 years = 36 f/ml-yrs

Many workers in asbestos-related trades will be exposed for more than one day per week. Changing Anderson's illustration to an exposure of 2 days per week puts cumulative exposure above 15 f/ml-year, the point at which the risk for asbestos-related disease occurs, according to Dr. Moolgavkar.

Example 2

What if a person were exposed at 1.0 f/ml for more than one day a week for a 20-year period?

1 f/ml x 2/5 x 20 years = 8 f/ml-yrs

1 f/ml x 3/5 x 20 years = 12 f/ml-yrs

1 f/ml x 4/5 x 20 years = 16 f/ml-yrs

Cumulative exposures decrease, yet exceed Moolgavkar's 15 f/ml-year threshold at four days per week.

Example 3

What if a person were exposed to varying levels of airborne asbestos fibers (10 f/ml and 0.001 f/ml, TWAs) for a 20- and 10-year work period?

((1/5 days x 10 f/ml) + (4/5 days x 0.001 f/ml)) x 20 years = 40 f/ml-years

((1/5 days x 10 f/ml) + (4/5 days x 0.001 f/ml)) x 10 years = 20 f/ml-years

For approximately 52 out of 260 work days a person could be exposed to 10 f/ml, for 10 years, and exceed the Moolgavkar threshold of 15 f/ml-years.

Example 4

What are different exposure scenarios that may lead to a cumulative exposure of about 15f/ml-yr, the threshold below which it is asserted that no asbestos-related disease can occur?

X f/ml x 1/5 x **45 years** = 15 f/ml-years
X = 1.7 f/ml

X f/ml x 1/5 x **20 years** = 15 f/ml-years
X = 3.8 f/ml

X f/ml x 1/5 x **10 years** = 15 f/ml-years
X = 7.5 f/ml

According to Anderson's rationale, and Moolgavkar's threshold of 15 f/ml-years, for a 45-year period, for one day a week, a person would have to be exposed to 1.7 f/ml in order to reach the point at which disease could occur. The historical data show that this concentration was not unusual decades ago. As the examples above illustrate, higher exposures for one day per week or for more than one day per week reduce the length of time required to reach the 15 f/ml-years threshold, or any other f/ml-years threshold. This methodology of fiber-years calculation ignores the spikes or "peaks" of exposure that can and do occur. According to Dodson "When exposure data have existed and have been used to determine the risk of disease such determinations have been based on a calculation of fiber-years of exposure (fibers/cm^3 x years of exposure). Such calculations have led to few conclusions…"[48]

These "peaks" of exposure matter in the inhalation and retention of asbestos fibers. According to reviewed works by Dodson, "The process as described for clearance from the lung represents the ideal response to dust inhalation and its rapid elimination from the lung. In many instances, exposure to dust can result in periods of "dust overloading" of the defense mechanisms…The impact of elevated dust burden and risk of developing

permanent pathological changes in the respiratory system lie in part with the level of inherent toxicity associated with the accumulated dust."[48]

Exposure has two components, concentration and duration, which vary with time, job conditions, tasks, etc. "Put very basically, "toxicity" and "hazard" are not synonymous. Toxicity is the ability of a stressor to cause damage to living tissue. It is a property of the stressor just like the material's boiling point, vapor pressure, or viscosity. However, hazard is the likelihood of illness or injury associated with the use of a stressor and, as such, is much more influenced by the conditions of use rather than by the toxicity of the stressor…A workers risk from handling a chemical is a function of both the level of exposure (including duration and concentration) and the toxicity of the chemical. Increasing the exposure or the toxicity of the chemical will result in increased risk. Therefore, risk assessment requires a two phased approach: exposure assessment and toxicity assessment."[14]

The installation of many asbestos-containing products that produced breathable dusts in the peak consumption era of asbestos use was a significant exposure hazard. According to the WHO, noted in a letter, "exposures of workers and other users of asbestos-containing products is [sic] extremely difficult to control."[79] "The people most likely to have high exposure to asbestos are workers who come into contact with asbestos while on the job. This includes people involved in the mining of asbestos and asbestos-containing minerals and manufacture of asbestos-containing products, and also people who ***install****, service, remove, or use these products."[47] {emphasis added}*

8. Standard methodologies exist to measure airborne asbestos concentrations by PCM and TEM. The methods produce different information, and results from one method do not equate directly to the other. PCM (NIOSH 7400) is not asbestos fiber specific and counts all fibers which meet the size criteria for the method. TEM methods detect/count fibers which are shorter and thinner than does the PCM method, and the TEM methods report only asbestos structures, by mineral type (chrysotile, amosite, etc.) There are several standard TEM methods, including one which records only asbestos fibers meeting the same size criteria that would be counted by the standard PCM method. PCM counts for asbestos fibers only can be derived retrospectively from some TEM data without re-examining the sample filter. The reverse is not true, however, and what the TEM results would have been cannot be reliably deduced retrospectively from PCM data alone.

Because PCM is not asbestos specific, fibers which are not asbestos are also counted. When filters are also analyzed by TEM, if samples contain many non-asbestos fibers, the TEM results may be lower because only asbestos fibers will be counted in the TEM analyses. However, if asbestos fibers less than 5 micrometers in length and/or asbestos fibers too thin to be detected by PCM are abundant in samples, the TEM results may exceed the PCM results.

Grace expert Lees uses an algorithm to ratio historic PCM exposure data. The method reduces the PCM numbers (air samples) by a factor derived from the percent of asbestos in the bulk products (material samples). This analysis assumes that all product constituents (asbestos and non-asbestos) become airborne in the same ratios as they are present in the bulk, that the aerodynamic properties of all constituents are the same, that the fiber size distribution is the same for all constituents, and that all non-asbestos constituents are fibers that would be counted by PCM (rather than being largely composed of particles which would not be counted by the method). None of these assumptions has been validated, and none can pass the test of common sense. Additionally, the method by Lees ignores the presence of short and thin asbestos fibers, which are also carcinogenic, because those were not measured in the historic PCM data.

Air sampling is the standard industrial hygiene technique to determine if airborne asbestos is present contemporaneous with the measurement. Both personal and area

sampling can be used, and analysis of samples can be done with phase contrast microscopy (PCM) or transmission electron microscopy (TEM). The best way to assess fiber release "is to measure asbestos fibers in the air. This approach is appealing because it quantitatively measures airborne asbestos contamination. However, it measures only current conditions and provides no information about fiber release potential and future air levels."[18]

It is important to understand that the PCM method does not distinguish asbestos fibers from other fibers, nor does it distinguish one asbestos mineral type from another. The TEM method, in combination with other analytical methods, distinguishes asbestos from other materials and determines which mineral types of asbestos are present.

9. Grace products can be described as cementitious because some of the constituents are similar to those of construction cements (e.g., gypsum, Portland cement). This adjective is not accurate to indicate that the products are as hard as concrete. The products are friable and do release asbestos fibers and structures to the air when disturbed. The data are also clear that the spray-applied products release asbestos from the matrices over time, even absent physical disruption of the products.

In my experience, when settled dust samples are collected in facilities where spray-applied fireproofing or spray-applied acoustical plaster is present, results range from above background to extremely high. This shows that these materials release asbestos over time. Some release is caused by damage to the materials, and some release occurs as the material ages. Ewing measured asbestos in settled dust in a study. The products in the facilities were fireproofing and acoustical plaster. Ewing does not address the brand names or manufacturers in the paper. Every building in the study which contained these products had at least one sample positive for asbestos. Some samples were as high as, or higher than, 50,000,000 s/cm^2. Outside samples in the study averaged 5,100 s/cm^2, with a range from below the limit of detection to 140,000 s/cm^2. Samples from buildings with no known surfacing ACM averaged 1,000 s/cm^2, with a range of below the limit of detection to 210,000 s/cm^2.[62]

Longo's study of an attic in Tucson notes that the fireproofing product was confirmed to be Grace Monokote 3. He notes that "inspection of horizontal surfaces below sprayed decking and beams showed evidence of fireproofing dust in the attic. Most surfaces were covered with a layer of fine dust and in the sporadic areas throughout the space pea sizes to fist size chunks of fireproofing debris were also present."[35] Longo reports the dust was disturbed by various activities and airborne results ranged from 0.60 to 15.94 s/cc (>5.0 microns). The asbestos in the dust clearly came from the fireproofing product. It did not "walk" in from somewhere else.

The EPA recognizes the concept of friability relative to the exposure risk associated with in-place ACMs. The agency's regulations for demolition and renovation require methods to control release of fibers to the environment when ACMs to be disturbed are friable in-place and when ACMs which are not friable in-place will be rendered friable by the intended disturbance. Surfacing ACM will release asbestos fibers into the air when it "…has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or, if applicable, which has delaminated such that its bond to the substrate (adhesion) is inadequate or which for any other reason lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM. Asbestos debris originating from the ACBM in question may also indicate damage."[100] {ACBM= Asbestos-containing building material} Physical damage caused by actions such as scraping, sanding, and grinding has been well documented to cause asbestos release. The disturbance of ACMs poses such a risk of exposure that current OSHA regulations require certain special procedures to be followed when ACMs are disturbed, regardless of measured airborne exposure.[1]

Grace experts assert that these products cannot release asbestos from their matrices because they are cementitious. It is true that these products are composited from ingredients similar to what commonly is called cement in the building trades. However,

*they are by no means as hard as other construction concretes/cements. They yield to hand pressure and have been consistently classified by the EPA as friable. The EPA maintains that "*Friable asbestos material *means any material containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure."*[63] *Furthermore, "Friable asbestos-containing materials are materials that were used for fireproofing, thermal and acoustical insulation, or decoration in building construction and renovation…these materials were usually applied by spraying but have also been applied by troweling. They are friable in varying degrees depending on the components of the material, the amount of cement added, and the method of application"*[16] *Regardless of the varying degree of friability a fireproofing or acoustical material may have, the EPA still deems these products as friable. Campopiano et al., clearly make a distinction between asbestos cement based products and sprayed on asbestos products, "Asbestos-cement materials are a good example of asbestos locked inside the product and generally do not constitute a significant source of airborne asbestos fibers, as long as they remain in good repair. The use of asbestos in spray-on fireproofing products, however, is an example of asbestos unlocked; these products, similar to the other friable products, can more easily release fibers into the environment."*[101] *The EPA still regards these spray-applied products as friable.*

Typical construction concrete has a compressive strength of 2,000 to 4,000 pounds per square inch (psi). Technical data for Monokote lists the compressive strength as "more than 70 psi."[102]

Spray-applied asbestos products can be removed or damaged by scrapping with the bare hand, various tools, or by even accidentally rubbing up against the material. The Hazards Campaign/TUC Guide asks questions like "What is the condition of the material now? – if it is already crumbling or breaking away from the base, complete removal should be considered."[103] *Grace experts are disingenuous at best in suggesting that these products cannot release asbestos because they are like cement. The EPA makes this*

distinction, "Surfacing materials can be friable and non-friable. Friable forms are either very fibrous and fluffy (sometimes like cotton candy) or granular and cementitious."[18] *(Reinforced in the "Blue Book" as well, pg. 3-4). The ASTM International by Task Group E06.24.03 clearly states that when working with and maintaining installed asbestos-containing cement products the goal "is to minimize the amount of airborne asbestos fibers that could be inhaled by workers or member of the community. Minimizing the release of asbestos fibers into the air during the operation is a primary objective. A secondary objective is to minimize the amount of dust and debris created and to prevent the re-entrainment of asbestos fibers into the air."*[64]

My opinions may be supplemented or changed if new evidence is presented to me.

Sincerely,

Steve M. Hays, PE, CIH, FACEC
Chairman
Gobbell Hays Partners, Inc.

APPENDIX A

Curriculum Vitae for Steve M. Hays PE, CIH

GOBBELL HAYS PARTNERS, INC.
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EDUCATION:

Bachelor of Engineering/Chemical Engineering/1973
Vanderbilt University; Nashville, Tennessee

CERTIFICATIONS/REGISTRATIONS:

1978/Professional Engineer/Tennessee
1982/Professional Engineer/Alabama
1983/Professional Engineer/New Mexico
1989/Professional Engineer/Arkansas
1989/Professional Engineer/Florida
1989/Professional Engineer/Illinois
1990/Certified Industrial Hygienist/American Board of Industrial Hygiene
1990/Chartered Membership/The Institution of Engineers of Ireland
1991/Professional Engineer/Virginia
1991/Professional Engineer/California
2000/Professional Engineer/Ohio
1996/Qualified Environmental Professional/The Institute of Professional Environmental Practice

PROFESSIONAL SUMMARY:

Mr. Hays, GHP partner and chairman of the board, is the driving force behind the firm's development as a recognized leader in dealing with hazards in the built environment. His background in the chemical industry, his certification as an industrial hygienist, and his knowledge of building systems give him a unique expertise in providing consulting services related to environmental hazards. His involvement since 1981 in environmental management

and/or abatement design at over 10,000 facilities has helped give Gobbell Hays Partners, Inc. (GHP) a national client base, with projects in geographic locations from San Juan, Puerto Rico, to Anchorage, Alaska.

Mr. Hays serves as a seminar faculty member at Georgia Tech Research Institute and The Environmental Institute. He is a former guest lecturer at the University of California at Berkeley and Texas A & M University. Mr. Hays has lectured on the following environmental-related topics:

Asbestos

Abatement Site Safety Update
Asbestos Abatement in Occupied Facilities
Asbestos Abatement Oversight and Management
Asbestos Abatement in Industrial Settings
Bulk Sampling and Documentation Procedures
Cost Estimating
Designing the Abatement Project: Design Laboratory
Design: Project Specifications
Design Update: Abatement Specifications
Design Update: AHERA and Beyond
Design Update: Special Design Considerations
Design Update: Mini-Laboratory Workshop
Development and Implementation of Contract Specifications
Elements of Technical Specifications for Asbestos Abatement Projects
Glovebag Techniques as an Abatement Response Action
HVAC System Modification During Abatement Projects
Inspection and Assessment Techniques
Lockdown/Replacement Techniques and Asbestos Substitutes
Pre-Inspection Planning
Pre-Work Activities and Considerations
Presentation of the NIBS Operations and Maintenance (O&M) Work Practices Manual
Project Design Considerations
Relevance of Settled Dust to the Design of Operations and Maintenance Programs and Abatement Projects
Understanding Building Systems

Environmental Audits/Assessments

Case Studies in Environmental Site Assessments
Chemistry and Environmental Laboratory Review

Pesticides, Insecticides, Herbicides and Fertilizers
Polychlorinated Biphenyls (PCBs)
Roles and Responsibilities of Consultants and Owners
Underground Storage Tanks: Regulations, Assessments and Corrective Measures

Lead-Based Paint

Abatement Design Strategies: Design Laboratory
Control Options
Contract Specifications and Critique
Project Management

Mold

Mold Assessment and Remediation in Buildings

Other Lectures

Design of a Transmission Electron Microscopy (TEM) Laboratory

Has lectured at University of Kentucky, Texas A & M, and New York University on asbestos-related topics.

COMMITTEES/COMMISSIONS:

Environmental Protection Agency (EPA)

Member, Policy Dialogue Committee to advise EPA on future regulation concerning asbestos-containing material in public and commercial buildings.

Peer reviewer for several EPA documents, including Managing Asbestos In Place ("Green Book").

Member, 24-person committee seated by EPA to negotiate the regulatory language as required under the Asbestos Hazard Emergency Response Act (AHERA), effective December, 1987.

The Environmental Information Association

Past President, The Environmental Information Association.

Past Secretary, National Asbestos Council.

Past Member of the Board, National Asbestos Council.

Past Chair, Awards and Sponsorship Committee for National Asbestos Council.

Past Chair, Professional Registration Committee for National Asbestos Council.

Past Co-Chair, ad-hoc membership group to study professional practice guidelines for the National Asbestos Council.

Past Chair, ad-hoc committee to establish liaison memberships with other professional associations for the National Asbestos Council.

National Institute of Building Sciences (NIBS)

Past Chair, Board of Directors for NIBS
Past Member, Indoor Air Quality Task Force for NIBS

Past Member, Project Committee for NIBS for preparation of lead-based paint abatement guidelines

Past Member, Task Force Steering Committee for preparation of asbestos abatement guideline specifications

Past Member, Radon Standards Project Committee

Past Chair, Asbestos Project Committee

Past Member, Consultative Council

Past Member, 1993 Consultative Council Planning Committee

Past Member, Environmental Integration Committee

Past Member, NIST Steering Committee

Additional Positions

Member, Advisory Committee on Childhood Lead Poisoning Prevention, Centers for Disease Control and Prevention (CDC)

Member, Indoor Environmental Quality Committee for the American Industrial Hygiene Association (active member from June 1994 – December 2001)

Chair, Lead Subcommittee of the Indoor Environmental Quality Committee for the American Industrial Hygiene Association

Member, Editorial Advisory Board for *American Consulting Engineer*, a publication of the American Consulting Engineers Council

Member, Editorial Advisory Board for *Lead Detection & Abatement Contractor*

Member, Editorial Advisory Board for *Indoor Environment Connections*

Facilitator and Expert, Peer Review Panel for HUD's Healthy Homes Initiative

Past Chair, Committee of Visitors for the School of Engineering, Vanderbilt University

Peer Reviewer, "HUD Guidelines for Evaluation and Control of Lead-Based Hazards in Housing"

Member, Committee on Sampling and Analysis of Atmospheres for the American Society for Testing and Materials (ASTM)
Member, Committee on Performance of Buildings for the American Society for Testing and Materials (ASTM)

Past Chair, Public Relations Committee for the American Consulting Engineers Council (ACEC)

Past Member, Environmental and Public Health Council, Underwriters Laboratories Inc.

Past Member, Committee seated by the Society for Occupational and Environmental Health for the development of the document "Protecting Workers and Their Communities from Lead Hazards: A Guide for Protective Work Practices and Effective Worker Training." The document was developed to protect workers and community health during lead-based paint abatement

Past Vice Chair, Tennessee Air Pollution Control Board

Past Member, Editorial Review Board for <u>Asbestos Abatement</u>

Past Member, Editorial Review for the National Asbestos Council <u>Journal</u>

Past Chair, The Lewis Society (Vanderbilt University, School of Engineering)

Past President, Vanderbilt University Engineering Alumni Council

Past Member, Vanderbilt University Alumni Board of Directors

Past President, Consulting Engineers of Tennessee

Past Co-Chair, Nashville Mayor Richard Fulton's Task Force to Improve Building Code Department Operations

Past Chair, Nashville Mayor Fulton's Rehabilitation Building Code Task Force

Past Member, State of Tennessee's Insurance Commissioner's Review Panel on Tennessee Building and Fire Codes as a representative of Tennessee Society of Professional Engineers

PRESENTATIONS:

“Forensic Architecture and Environmental, Health, and Safety Services” presented to Sunrise Senior Living, May 31, 2007.

“Nanotechnology Research Laboratories and EHS Issues” presented at the EIA Conference March 19, 2007.

Review and update of Project Designer Issues, presented at The Environmental Institute November 29, 2006.

Review and Update of Asbestos Inspector Issues, presented at The Environmental Institute November 28, 2006.

“Post-Remediation for Lead,” presented at the American Industrial Hygiene Conference & Exposition, Chicago, IL, May 17, 2006.

“The Technical Aspects of The Meth Issue,” presented at the Twenty-Third Annual Conference and Exposition of the Environmental Information Association, Phoenix, AZ, March 27, 2006.

“Chemical Engineering ’73,”presented to Vanderbilt University School of Engineering, Nashville, TN, November 16, 2005.

“The Creation by Professionals of a Remediation Plan,” presented at the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by Ecobuild America), Orlando, FL, June 21, 2005.

“Interpretation of South Texas Airborne Fungi Data,” podium session presented at the American Industrial Hygiene Conference and Exposition, Anaheim, CA, May 23, 2005.

“Manganese in Welding Fume,” presented at the Twenty-Second Annual Conference and Exposition of the Environmental Information Association, New Orleans, LA, March 23, 2005.

"Industrial Hygiene Perspective," presented at Mealey's Welding Rod Litigation Conference, West Palm Beach, FL, October 7, 2004.

"Mold Amplification Associated with New Construction," presented at the 2004 Boulder Conference, *Mold in the Indoor Environment: Assessment, Health and Physical Effects, and Remediation* (sponsored by ASTM), Boulder, CO, July 26, 2004.

"Buildings and Mold Alliance Update," developed for the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by the Building Environment and Thermal Envelope Council), Chicago, IL, July 15, 2004.

"The Creation by Professionals of a Remediation Plan," presented at the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by the Building Environment and Thermal Envelope Council), Chicago, IL, July 15, 2004.

"Welding Processes and Government Regulations," presented at the conference, Welding Rods: An In-Depth Look at Emerging Litigation (sponsored by HarrisMartin Publishing), San Francisco, CA, June 16, 2004.

"A Study of Exposure to Manganese in Welding Fume and Characterization of the Manganese in the Fume," presented at the Conference on Health Effects of Manganese: Research, Industrial Hygiene, and Clinical Issues in Occupational Exposures, New Orleans, LA, April 18, 2004.

"Mold, the National Institute of Building Sciences, and Environmental Safeguards," presented to the Environmental Bankers Association, San Antonio, TX, January 20, 2004.

"Industrial Hygiene Measurements of Total Fume and Manganese Exposures to Welders," presented at the conference, Manganese Exposure in Welders: Health Effects, Clinical Outcome, Research Methods (sponsored by the California Department of Health – Occupational Health Branch), Oakland, CA, August 1, 2003.

"Executive Summary; Mold and the Hospitality Industry," presented to executives of Marriott International, Inc., Bethesda, MD, June 27, 2003.

"The Indoor Environment (Indoor Air Quality and Mold)," presented at BOMA luncheon, Austin, TX, June 19, 2003.

"Mold Remediation: Just Clean It Up?," presented at Mold Litigation: Beyond the Basics II (sponsored by HarrisMartin Publishing), New Orleans, LA, June 13, 2003.

"Health Issues: Toxicity, Occupancy, and Air Quality," presented at BETEC 2003 Spring Symposium, Washington, DC, June 5, 2003.

"What Industrial Hygienists Need to Know About Buildings and Construction to Identify and Resolve IEQ Problems," professional development course presented at the American Industrial Hygiene Conference and Exposition, Dallas, TX, May 11, 2003.

"The Indoor Environment (IAQ, Mold, and Terrorism)," presented at the 2003 National Property Management Conference, sponsored by USAA Realty Company, San Antonio, TX, March 28, 2003.

"Asbestos in Surface Dust – Lessons from New York and Elsewhere," professional development course presented at the 20th Annual Conference and Exposition of the Environmental Information Association, Savannah, GA, March 23, 2003.

"When AHERA Does Not Make Sense," forum presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA, June 3, 2002.

"What Industrial Hygienists Need to Know About Building and Construction to Identify and Resolve IEQ Problems," professional development course presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA, June 2, 2002.

"The Science and Art of Environmental Mold Investigations," lecture presented at *Mold Medicine & Mold Science, Its Practical Applications for Patient Care*, hosted by the International Center for Toxicology and Medicine (ICTM) and the Department of Pharmacology at Georgetown University, Washington, DC, May 14, 2002.

Roundtable I and Roundtable II, discussions at *Mold Medicine & Mold Science, Its Practical Applications for Patient Care*, hosted by the International Center for Toxicology and Medicine (ICTM) and the Department of Pharmacology at Georgetown University, Washington, DC, May 13 and 14, 2002.

"OSHA Standards for Science Labs," lecture presented to the Tennessee Board of Regents, Nashville, TN, April 17, 2002.

"Mold Investigations for Insurance Claims in South Texas," lecture presented at the 19th Annual Conference and Exposition of the Environmental Information Association, San Antonio, TX, March 27, 2002.

"Building Construction, Systems, and Moisture," lecture presented at the USAA Realty Company 2001 National Management Conference, San Antonio, TX, November 13, 2001.

"Lead Hazard Evaluation and Control in Buildings Using ASTM E 2052-99," professional development course presented at the American Industrial Hygiene Conference and Exposition, New Orleans, LA, June 2, 2001. Co-presenter.

"Indoor Air Quality; Typical Problems and Solutions," lecture presented at the USTA Environmental Conference and Showcase, Dallas, TX, May 22, 2001.

“What Industrial Hygienists Need to Know About Buildings and Construction,” lecture presented at the 18th Annual Conference and Exposition of the Environmental Information Association, Phoenix, AZ, March 25, 2001.

“Introduction to Indoor Air Quality,” “EPA’s Tools for Schools Action Kit,” and “Maintaining IAQ During Renovations,” lectures presented at “Indoor Air Quality Tools for Schools” seminar sponsored by the Colorado Department of Public Health and Environment, Denver, CO, June 1, 2000.

“Lead Hazard Management Program Training for U.S. General Services Administration Employees,” lecture prepared for the American Industrial Hygiene Conference and Exposition, Orlando, FL, May 22, 2000.

"Indoor Air Quality 101," lecture presented to the Association of School Business Officials International conference, Orlando, FL, October 18, 1999.

"Insuring Accuracy in Indoor Air Quality Investigations Involving Microbial Contamination," lecture presented to the National Environmental Health Association's Indoor Air Quality conference, Nashville, TN, July 7, 1999.

“Application of ASTM D-5755 for Measurement of Asbestos in Settled Dust to Assess Contamination and Clear Abatement Projects,” lecture presented at the American Industrial Hygiene Conference and Exposition, Toronto, Ontario, Canada, June 10, 1999.

“Lead Hazard Management Program Training for U.S. General Services Administration Employees,” lecture presented at the American Industrial Hygiene Conference and Exposition, Toronto, Ontario, Canada, June 7, 1999.

“Healthy School Environments; Cleaning and Maintenance Strategies,” lecture presented at Indoor Environment 99, Austin, TX, April 21, 1999.

“Engineering Insight Into Why Buildings Can Make Your Patients Sick,” lecture presented to Tennessee Thoracic Society, Vanderbilt University, April 10, 1999.

“Indoor Air Pollution,” lecture presented to the Department of Civil and Environmental Engineering, Vanderbilt University, April 5, 1999.

“Environmental Chemistry for the Scientifically Challenged,” lecture presented at the 16th Annual Conference and Exposition of the Environmental Information Association, San Antonio, TX, March 29, 1999.

“Indoor Air Quality in Chemistry Laboratories,” lecture presented at The Pittsburgh Conference (Pittcon ’99), Orlando, FL, March 10, 1999.

"Indoor Air Quality," lecture presented to the Tennessee Board of Regents, November 19, 1998.

"Programming for Laboratory Design," lecture presented to the Tennessee Board of Regents, Nashville, TN, November 18, 1998.

"Identification of and Testing for Lead Hazards: Transforming Inspection and Assessment Results into Action," lecture presented at Lead Tech '98 Conference & Exhibition, October 26, 1998.

"Identification of and Testing for Lead Hazards," lecture presented at the 1998 National Lead Grantee Conference, Phoenix, AZ, June 23, 1998.

"Environmental Chemistry for the Scientifically Challenged," lecture presented at the Institute of Real Estate Management, Las Vegas, NV, June 20, 1998.

"Solving a Serious Indoor Air Quality Problem with Electron Microscopy Analysis," lecture presented at the American Industrial Hygiene Conference and Exposition, Atlanta, GA, May 13, 1998.

"IAQ Tools for Schools," lecture presented at School Air Quality and Asthma Workshop, (cosponsored by the U.S. Environmental Protection Agency), April 29, 1998.

"Maintaining Acceptable IAQ During Renovations," lecture presented at Indoor Environment '98, April 16, 1998.

"Bioaerosol Exposures in Multi-Building Complex with Significant Water Infiltration," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 25, 1998.

"Using Pilot Projects to Determine Proper Methods for Lead-Based Paint Abatement in Housing Authority Projects," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 24, 1998.

"Criminal Proceedings in Federal Court: How Not to Remove Asbestos," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 23, 1998.

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"Worker Lead Safety - Current Methods in Prevention & Control, Part I," lecture presented at Lead Tech '97 Conference & Exhibition, October 1, 1997.

"Incorporating Dust Sampling Into the Asbestos Management Program," lecture presented at ASTM's Boulder Conference, July 17, 1997.

"Top 10 Controversies in the Indoor Environment," lecture presented at Indoor Environment '97: Setting the Standard for Healthy Building Management, April 7, 1997.

"Asbestos Dust Contamination - How Much is Too Much?" Professional Development Seminar: 14th Annual Conference and Exposition of the Environmental Information Association, March 23, 1997. Co-Presenter.

"Pesticide Exposures Related to Construction Activities," presented at the American Industrial Hygiene Association/Indiana Section, March 19, 1997.

"Managing an Effective Environmental, Health, and Safety Program", lecture presented at the American Industrial Hygiene Conference and Exposition, Washington, D.C., May 23, 1996.

"Questions of Risk Management in Schools and Public Buildings: The American Experience," lecture presented at Amiante (Paris, France), April 26, 1996.

"The Top Five IAQ Controversies: What Every Professional Should Know," lecture presented at the American Industrial Hygiene Association/Indiana Section, February 13, 1996.

"The Top Ten IAQ Controversies: What Every Professional Should Know," lecture presented at Indoor Environment '95: Strategies for the New Era of Regulation, May 2, 1995.

"NIBS Lead-Based Paint Operations and Maintenance Manual Development and Use," lecture presented at the Twelfth Annual Conference and Exposition of the Environmental Information Association, April 25, 1995. Co-Presenter.

"Asbestos O&M Practices and Procedures at EPA Occupied or Controlled Facilities," lecture presented at the Twelfth Annual Conference and Exposition of the Environmental Information Association, April 24, 1995. Co-Presenter.

"U.S. EPA Lead Regulations and Activities: A Question and Answer Session," Twelfth Annual Conference and Exposition of the Environmental Information Association, April 24, 1995. Co-Presenter.

"Indoor Air Quality: Solutions and Strategies," Professional Development Seminar: Twelfth Annual Conference and Exposition of the Environmental Information Association, April 22, 1995. Co-Presenter.

"Sampling and Analysis for Asbestos in Settled Dust," Professional Development Seminar: Twelfth Annual Conference and Exposition of the Environmental Information Association, April 22, 1995. Co-Presenter.

"Interpretation of Scientist's Needs and Wants," lecture presented during the Architect/Engineer In Laboratory System Design session at the American Society of Heating, Refrigerating and Air Conditioning Engineers' Winter Conference, January 29, 1995. Presenter.

"Indoor Air Quality," lecture presented to the Nashville Chapter of the American Institute of Architects. August 11, 1994.

"OSHA Indoor Air Quality Proposed Rule," seminar conducted by Gobbell Hays Partners, Inc. June 14, 1994.

"Investigation of Health Effects Complaints from Construction Workers at a Large Wastewater Treatment Plant," poster presentation at the American Industrial Hygiene Conference and Exposition, Anaheim, California. May 24, 1994. Co-Presenter.

"Developing a Scope of Work, Planning and Initiating the Phase I Environmental Site Assessment," lecture presented during the Professional Development Seminar Conducting Environmental Site Assessments: The ASTM Standard and Beyond at the American Industrial Hygiene Conference and Exposition. May 21, 1994.

"Strategies and Resources for Solving Indoor Air Quality Problems," lecture presented to Vanderbilt University Engineering Department. March 31, 1994.

"Conducting Indoor Air Quality Investigations: A Basic Primer," session presented at EM '94, the Environmental Information Association's Annual Conference and Exposition. March 14, 1994. Co-presenter.

"Settled Asbestos Dust Sampling and Analysis," Professional Development Seminar presented at EM '94, the Environmental Information Association's Annual Conference and Exposition. March 13, 1994. Co-presenter.

"Indoor Air Quality and Other Environmental Hazards," presentation at Willis Corroon's Environmental Risk Management Services' Broker Training Seminar, Nashville, Tennessee. February 1, 1994.

"Issues in Industrial Hygiene," session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"Overview and Analysis of Lead Abatement Methods," session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"Defining the Lead Detection and Abatement Industry," general session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"The Asbestos Operations and Maintenance Program," session presented at the 48th Annual Federal Safety and Health Conference, Chicago. October 6, 1993.

"Building Engineering in Today's Marketplace," lecture presented at Tennessee Technological University. September 10, 1993.

"What to Expect from an Environmental Site Assessment: Part I - What to Look For," lecture presented for Georgia Tech to the BellSouth Corporation. August 31, 1993.

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"Development of Health Protection Recommendations for CFC Replacement," presented to the American Industrial Hygiene Conference and Exposition. May 15- 21, 1993. Co-Presenter.

"Exposure Modeling for a Coolant to Replace CFC's in an Industrial Process," presented to the American Industrial Hygiene Conference and Exposition. May 15- 21, 1993. Co-Presenter.

"Data Evaluation and Report Writing," lecture presented during the Professional Development Seminar Conducting Environmental Evaluations: An Overview at the American Industrial Hygiene Conference and Exposition. May 15, 1993.

"ASTM Guide for Evaluation of Asbestos on Surfaces," lecture presented at the ASTM Conference. April 25, 1993.

"The Scope of Indoor Air Quality Problems," session presented at Indoor Environment '93. April 22, 1993.

"Managing IAQ During Building Renovation," session presented at Indoor Environment '93. April 21, 1993.

"Lead-Based Paint Design Strategies," training course conducted for the Memphis Naval Air Station, Millington, Tennessee. April 20-22, 1993. Co-Presenter.

"Case Study: HVAC Modifications for Asbestos Operations and Maintenance Purposes," poster session presented to the Health Effects Institute. March 8 - 9, 1993. Co-Presenter.

"Operations and Maintenance Programs in Buildings Containing Asbestos: A Workshop," presented to the Health Effects Institute. March 8, 1993.

"Level of Effort Required for Operations and Maintenance Work Practices," presented to the Health Effects Institute. March 8 - 9, 1993. Co-Presenter.

"Lead Abatement Strategies and Techniques," lecture presented at Lead in Charleston: Conference for Contractors. March 4, 1993.

"Writing Specifications for Lead Based Paint Projects," lecture presented at Lead Tech '92. October 2, 1992.

"NAC/The Environmental Information Association's Role in Development of a Lead Based Paint Abatement Infrastructure," lecture presented at Lead Tech '92. October 2, 1992.

"Occupational Exposure to Inorganic Lead," lecture presented at Lead Tech '92. September 30, 1992. Co-Presenter.

"The Use of Settled Dust in the Development of Asbestos Control Programs," lecture presented at the Johnson Conference. July 15, 1992. Co-Presenter.

"Lead-Based Paint Abatement: Learning the Lessons from the Asbestos Experience," roundtable session held at the American Industrial Hygiene Conference and Exposition. June 2, 1992. Co-Presenter.

"Data Evaluation and Report Writing," lecture presented during the Professional Development Seminar <u>Conducting Environmental Evaluations: An Overview</u> at the American Industrial Hygiene Conference and Exposition. May 30, 1992.

"Chemical and Laboratory Considerations," lecture presented during the Professional Development Seminar <u>Conducting Environmental Evaluations: An Overview</u> at the American Industrial Hygiene Conference and Exposition. May 30, 1992.

"Health Implications and Regulations in Asbestos Abatement," lecture presented to the Industrial Fabrics Association International. October 20, 1991. Co-Presenter.

"Asbestos: Legal Concerns," lecture presented at Selected Topics in Occupational Medicine Conference. September 14, 1991.

"Managing Asbestos in Place," lecture presented for the Environmental Protection Agency Safety, Health and Environmental Management Compliance Annual Conference. June 27, 1991.

"What is an O&M Program? What Training is Necessary?" lecture presented at Implementing Operation and Maintenance Programs for Asbestos-Containing Materials, sponsored by USEPA. June 4, 1991.

"What Does an O&M Program Include?" lecture presented at Implementing Operation and Maintenance Programs for Asbestos-Containing Materials, sponsored by USEPA. June 4, 1991.

"Asbestos at a Fire Scene," lecture presented at the Emergency Response Conference. April 5, 1991. Co-Presenter.

"Sick Building Syndrome: An Overview," lecture presented during the Minimizing Environmental Risk in Building Operation and Property Transfer session at the National Asbestos Council, Inc. Eighth Annual Asbestos Management Conference and Exposition. February 19, 1991.

"Interpreting the Results of an Environmental Audit Site Assessment," lecture presented during the Minimizing Environmental Risk in Building Operation and Property Transfer session at the National Asbestos Council, Inc. Eighth Annual Asbestos Management Conference and Exposition. February 19, 1991.

"Recent Research on Fiber Release from Asbestos-Containing Material and Re-entrainment of Asbestos Dust," session presented to The Third Wave of Asbestos Disease: Asbestos in Place, a conference under the auspices of the Collegium Ramazzini. June 1990. Co-Presenter.

"Recent Research on Fiber Release from Asbestos-Containing Material and Re-entrainment of Asbestos Dust," session presented to the National Asbestos Council, Inc. Seventh Annual Asbestos Abatement Conference and Exposition. February 1990. Co-Presenter.

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"Replacement Materials: How to Avoid the Pitfalls," session presented to the Asbestos Abatement Council of the Association of the Wall and Ceiling Industries -International. January 1990. Co-Presenter.

"Experimental Data for Project Design," 1989 session for the National Asbestos Council, Fall Technical Conference and Exposition. Co-Presenter.

"Mechanical Engineering and Asbestos Abatement Design," 1989 session for the National Asbestos Council, Sixth Annual Asbestos Abatement Conference and Exposition. Co-Presenter.

Testimony given before the Joint Hazardous Waste Committee, State of Tennessee, 1989.

"Executive Summary: Asbestos in Buildings," a joint seminar conducted by Gobbell Hays Partners, Inc. and Environmental Sciences, Inc., March 1989.

"Beyond AHERA - Building Inspection From the Designer's Point of View," 1988 session for the National Asbestos Council Fall Technical Conference and Exposition.

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"Asbestos Hazard Assessment," Association of the Wall and Ceiling Industries - International, Asbestos Abatement World Congress and Exposition, June 1987.

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"Contracting Asbestos-Related Work" and "Operations and Management," building owners, managers, contractors and architects, University of Kentucky-Lexington, October 1984; October 1985; November 1986; October 1987.

Operations and Maintenance Training for maintenance workers, and Asbestos Awareness Training for administrative officials and custodians at Evanston Township High School, Evanston, Illinois, 1986.

Asbestos awareness seminar for Indiana School Superintendents, 1986.

"Contract Specifications," EPA Regional Asbestos Coordinators, Georgia Institute of Technology, December 1985.

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"Asbestos Concerns," Nashville Chapter of Risk and Insurance Managers Society, Nashville, Tennessee, November 1985.

"Asbestos in the Built Environment," U.S. House of Representatives Committee on Appropriations, the Subcommittee on HUD and Independent Agencies, Washington, D.C., 1984.

PAPERS/PUBLICATIONS:

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“Best and Worst of IAQ in 2003,” Indoor Environment Connections, December 2003. Featured and quoted.

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"Mechanical Engineering and Replacement Design," paper presented to the National Asbestos Council, Sixth Annual Asbestos Abatement Conference and Exposition. Co-Author.

"Designing and Construction of an Asbestos Microscopy Laboratory Facility," Microscope, 1989. Co-Author.

"Designing a Transmission Electron Microscopy (TEM) Laboratory," NAC Journal, Spring 1988.

"The Importance of Dimensional Accountability," Asbestos Abatement, September/October 1988.

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"Dimensional Accountability," paper presented to the World Congress II and Exposition on Asbestos Abatement, The Asbestos Abatement Council of AWCI, May 1988. Co-Author.

"Writing Specifications for Asbestos Abatement Projects," 1988 Directory for National Insulation Contractors Association.

"A Chemical Engineer's Role in the Building Industry," Chemical Engineering, January 18, 1988.

"Case Study: Asbestos Abatement of Steam Generating Plant, Jacksonville, Florida," 1987 paper for the National Asbestos Council, Fall Technical Asbestos Abatement Conference and Exposition.

"Removing Asbestos-Containing Fireproofing, Anchorage, Alaska School Project," Insulation Outlook, March 1987.

"Asbestos Abatement and Removal, Bartlett High School, Anchorage, Alaska," 1986 paper for the National Asbestos Council, Third Annual Asbestos Abatement Conference and Exposition. Co-Author.

"Hazard Assessment: A Summary," Inter/Micro '86 (an international symposium of microscopists and scientists).

"Asbestos Removal in Public Schools," Inter/Micro '82.

AWARDS:

The Indoor Environment Quality Committee Past Chair Recognition of Excellence Award, presented at the American Industrial Hygiene Association Conference and Expo, May 2006.

Inducted into the College of Fellows of the American Consulting Engineers Council (now known as the American Council of Engineering Companies), October 1, 1999.

President's Citation Award for Outstanding Service, presented by the Consulting Engineers of Tennessee, 1991.

Outstanding Long-Range Planning Award, presented by the Consulting Engineers of Tennessee, 1990.

President's Award, presented by the Consulting Engineers of Tennessee, 1982.
President's Citation, presented by the Tennessee Society of Professional Engineers, 1981.

Tennessee Young Engineer of the Year, presented by the Tennessee Society of Professional Engineers, 1981.

Young Engineer of the Year, presented by the Tennessee Society of Professional Engineers-Nashville Section, 1981.

President's Award, presented by The Environmental Information Association, 1993/1994.

COURSES/SEMINARS:

Asbestos/Supervision

Supervision of Asbestos Abatement Projects: Course and Workshop/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, or Pioneer Environmental in 1989, 1991, 1993, 1994, 1995, 1996, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006

Asbestos/Inspection

Inspecting Buildings for Asbestos-Containing Materials/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, the University of Cincinnati, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006

Asbestos/Management Planning

Managing Asbestos in Buildings/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, the University of Cincinnati, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006

Asbestos/Abatement Design

Asbestos in Buildings: Designing the Abatement Project/1988, The Environmental Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006

Additional Courses

Florida Building Code – Building/Fire Safety/2003, American Institute of Architects & Tennessee Society of Professional Engineers

Air Monitoring Technician Refresher/2005, Pioneer Environmental

Mold Assessment and Remediation in Buildings/2001, The Environmental Institute

Lead Abatement Supervisor: EPA (Target Housing & Child-Occupied Facilities)/1999, The Environmental Institute

Lead-Based Paint Abatement Design Strategies/1998, Georgia Tech Research Institute

Lead Abatement for Supervisors and Contractors/1995, Georgia Tech Research Institute

Settled Dust Sampling: Asbestos and Other Particulates/1991, Georgia Tech Research Institute

Comprehensive Review for Industrial Hygiene Professionals/1990, University of Cincinnati Institute of Environmental Health

Respiratory Protection for Asbestos Abatement Projects/1989, The Environmental Institute

Hazardous Material Control & Emergency Response/1987, Georgia Tech Research Institute

AFFILIATIONS:

The Environmental Information Association (EIA)
American Academy of Industrial Hygiene (AAIH)
American Industrial Hygiene Association (AIHA)
National Institute of Building Sciences (NIBS)
American Council of Engineering Companies (ACEC)
Consulting Engineers of Tennessee (CET)
American Society for Testing and Materials (ASTM)
Air and Waste Management Association (AWMA)
American Conference of Governmental Industrial Hygienists (ACGIH)
The International Society of Indoor Air Quality and Climate (ISIAQ)

APPENDIX B

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